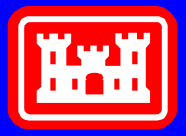
Planning Level Simulation Modeling of Channel Improvements

25-September-2007

Presented by:
Keith Hofseth



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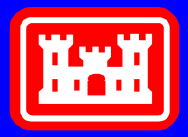


HarborSym

- Developed by the Corps of Engineers
- Non-proprietary
- Monte-Carlo simulation model
- Geographically portable

Need for Model

The Corps assists in the development of the nations ports. Evaluations of proposed port improvements where accomplished with tools and techniques developed by each port proponent. It was difficult to compare these analysis across ports. The need arose to apply the same standards and techniques to evaluate port investments to ensure equal treatment across the country.

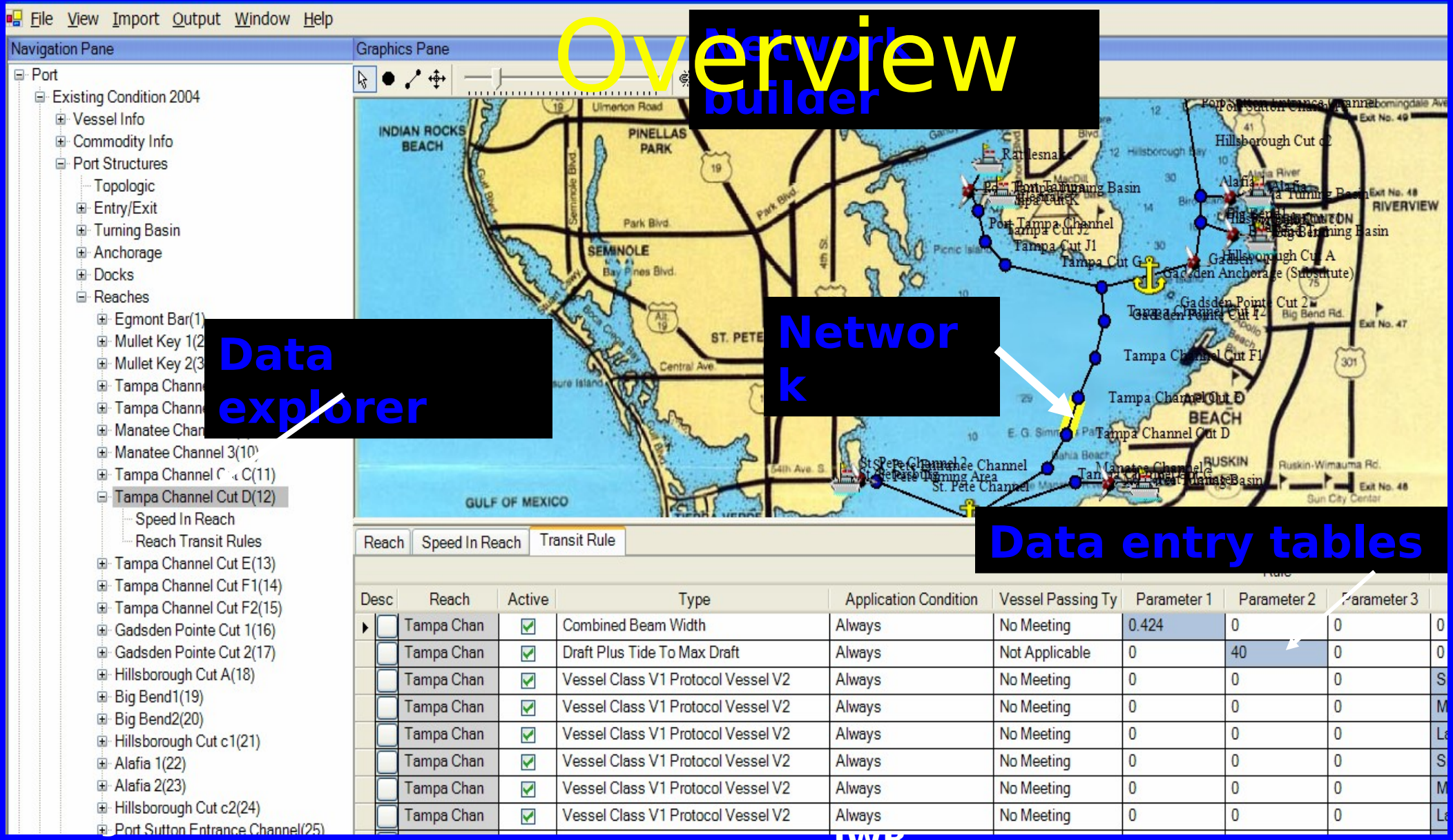
Need for Model

- Us army Corps of Engineers requires economic justification demonstrated through benefit-cost analysis.
- Benefits are measured by “willingness to pay”
- Willingness to pay is estimated by transportation savings due to the project

Sources of Transportation Savings

- Shorter dwell time for vessels (less delay)
- Loading Ships more efficiently (deeper)
- Allow use of larger ships

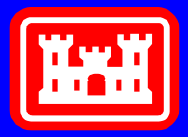
Model Overview



Desc	Reach	Active	Type	Application Condition	Vessel Passing Ty	Parameter 1	Parameter 2	Parameter 3	
▸	Tampa Chan	☑	Combined Beam Width	Always	No Meeting	0.424	0	0	0
	Tampa Chan	☑	Draft Plus Tide To Max Draft	Always	Not Applicable	0	40	0	0
	Tampa Chan	☑	Vessel Class V1 Protocol Vessel V2	Always	No Meeting	0	0	0	S
	Tampa Chan	☑	Vessel Class V1 Protocol Vessel V2	Always	No Meeting	0	0	0	M
	Tampa Chan	☑	Vessel Class V1 Protocol Vessel V2	Always	No Meeting	0	0	0	La
	Tampa Chan	☑	Vessel Class V1 Protocol Vessel V2	Always	No Meeting	0	0	0	S
	Tampa Chan	☑	Vessel Class V1 Protocol Vessel V2	Always	No Meeting	0	0	0	M
	Tampa Chan	☑	Vessel Class V1 Protocol Vessel V2	Always	No Meeting	0	0	0	La

Model Overview

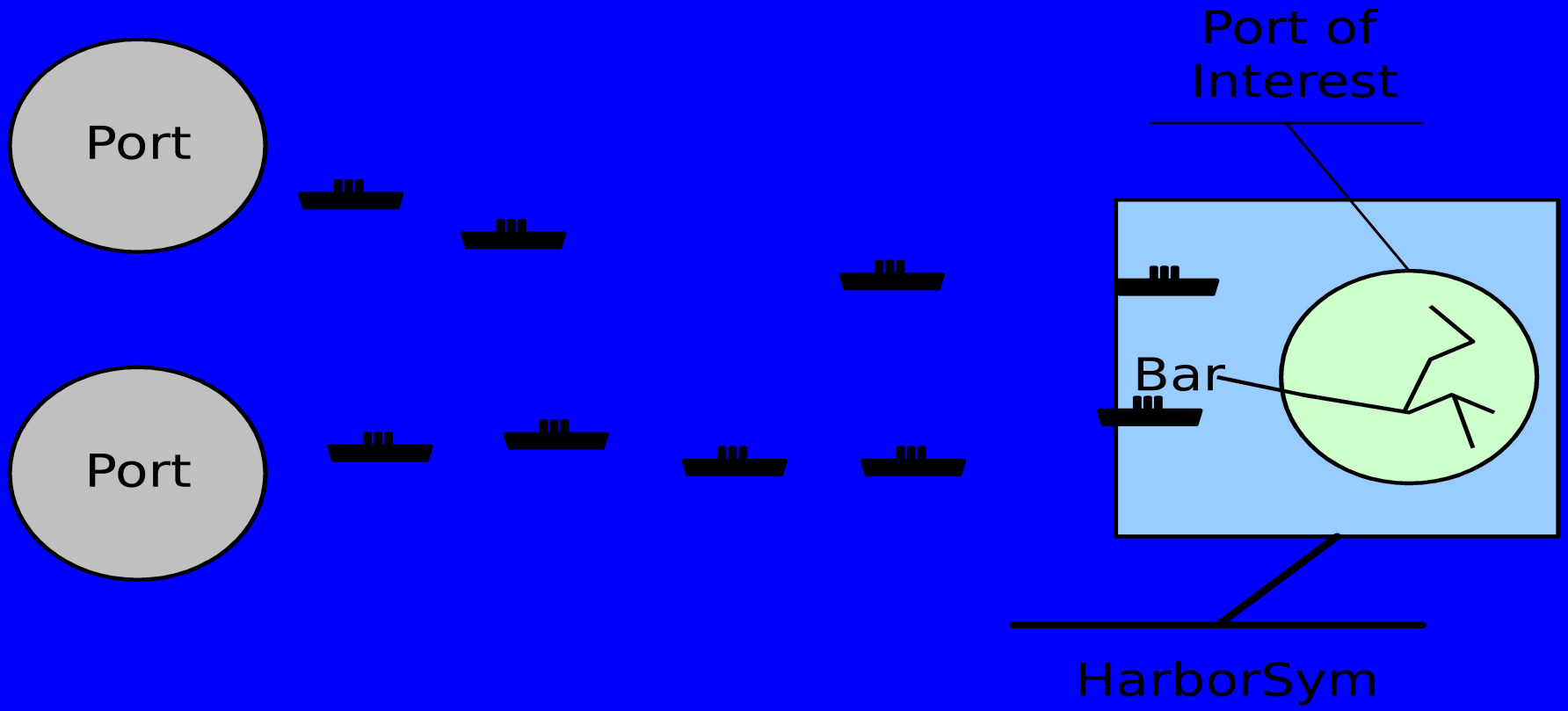
- Data sets define study area
- User interface provides access to data
- Computational kernel performs simulation



Model Overview

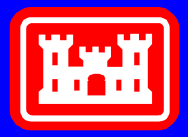
- Monte Carlo simulation model of vessel traffic for coastal harbors
- Estimates transportation cost changes due to harbor improvements
  - Calculates vessel time in harbor
  - Captures inefficient delay times
  - Incorporates risk and uncertainty

System Boundaries



Inputs and Outputs

- Inputs
  - Network (reaches, docks)
  - Commodity transfer rates
  - Vessel call specifics
  - Vessel speeds by reach
  - Transit rules by reach
- Outputs
  - Vessel times in system
  - Transportation costs
  - Rule violation statistics



Network Data Requirements

- Docks
  - Commodity-vessel correspondence
  - Commodity transfer rates
  - Capacity, physical parameters
  - Aggregation possible for modeling simplicity
- Reaches
  - Physical parameters including tidal influence
  - Vessel speeds
  - Transit restrictions
- Turning Basins & Anchorages
  - Capacity, physical parameters

Vessel Call Data Requirements

- Vessel physical parameters
- Date/time vessel arrives at the port
- Arrival draft
- Destination dock(s)
- Commodity transfer(s) at each dock

Transit Rule Descriptions

Single Vessel Rules

- Restrictions by dimensions
- Draft/ tide/ current restrictions
- Turning area or dock capacity

Multiple Vessel Rules

- Passing/overtaking restrictions by:
  - Vessel type
  - Physical dimensions
  - Commodities

Transit Rules Parameters of Application

Generic Rule Description	Example Parameters
Multiple Vessel Rules	
Combined Beam Width	No passing, ½ channel width
Priority Vessels	No passing priority ships
Single Vessel Rules	
Restricted Movement by Vessel LOA	800’ LOA maximum
Maximum Draft Plus Tidal Allowance	40’ + tide max draft

Assistance with Data Requirements

- User interface
  - Network builder
  - Vessel call import routine
  - Dock data import routine
  - Commodity data import routine
- Allocator/ Statistical Analyzer
  - Future call list generation

Transit Rule Data Requirements

- Location of application
  Rules must be defined in each reach
- Rule type
  General description of movement restriction
- Parameters of application
  Reach-specific rule definition

Additional Capabilities

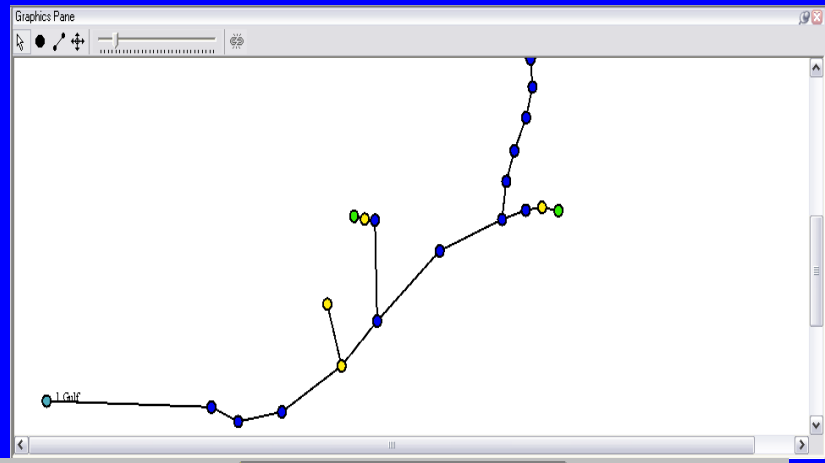
- Tide / Current

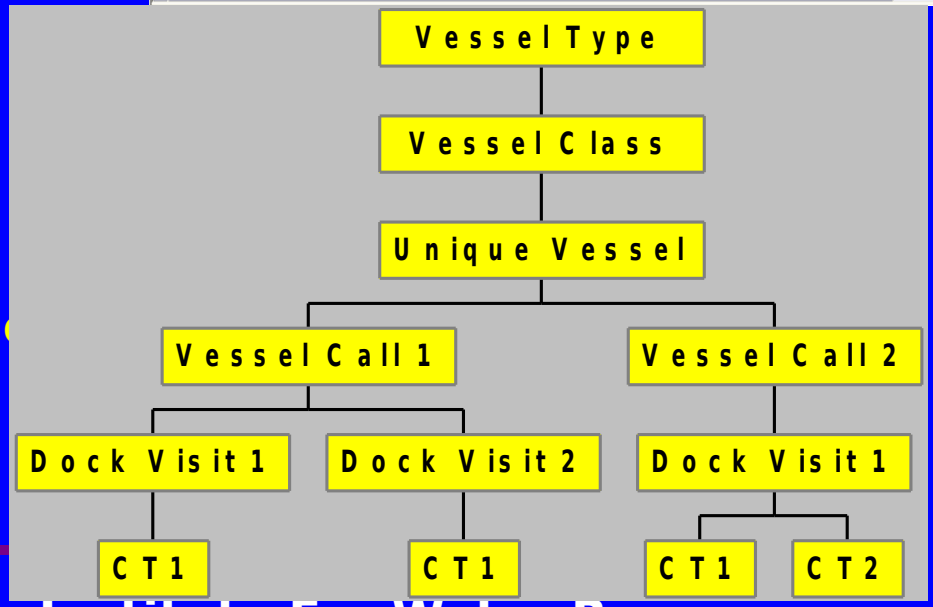
Data Bases

- Input Database (IDB)
  Description of study area (docks, channels, transit rules etc.)
- Vessel Call Database (VCDB)
  Vessels, vessel calls, commodity transfers
- Output Database (ODB)
  Output results from multiple runs
- Scenario Output Database (SODA)
  Output results from a single run
- Forecast Database (FCDB)
  Commodity forecasts, fleet, constraints

Port Information Data

- Port Physical Layout
  - Docks and Reaches
- Vessel Types (RoRo, Tanker, etc.)
  - Classes within Type (by size ranges)
- Commodity Categories
- Unique Vessels
  - Name / Vessel Class
  - Physical Characteristics
    - Beam / LOA / Capacity / TPI
- Calls
  - Time of Arrival / Arrival Draft
  - Dock Visit(s)
    - Commodity Transfers at Do

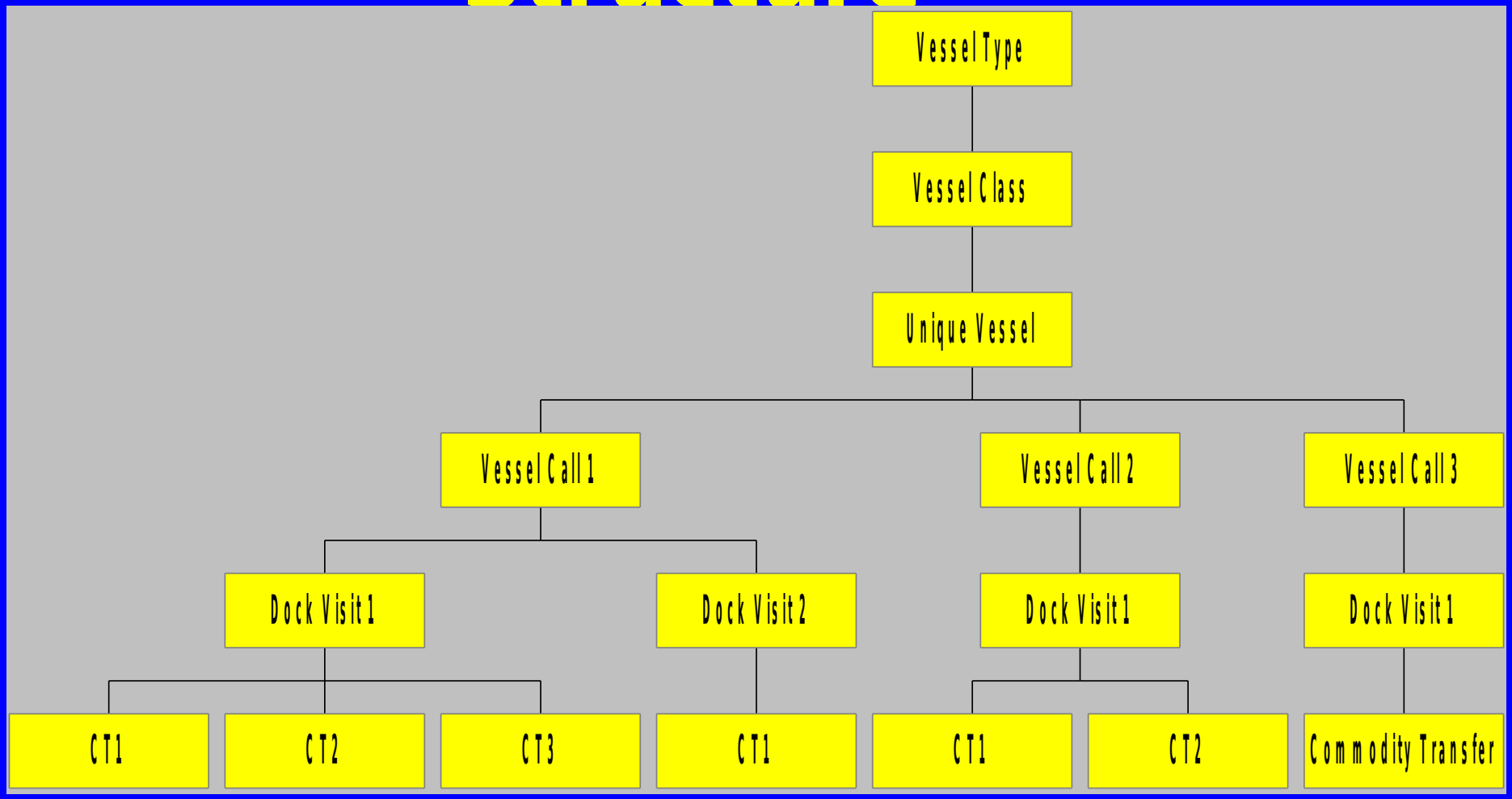




Vessel Call Data Base

- Unique Vessels
  - Vessel class
  - Physical characteristics
- Vessel Call
  - Arrival Time / Draft
  - Route Group
- Dock Visits
- Commodity Transfers
  - Quantity / Commodity Category
  - Import/Export

Vessel Call Database Structure

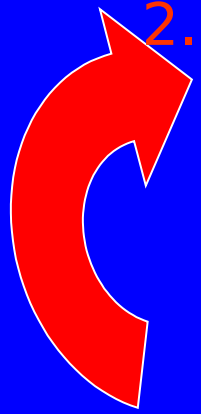


Commodity Driven Synthetic Vessel Call List Generator

- User Provides:
  - Commodity forecast at each dock
  - Dock depth limitations at each dock
  - Description of the available fleet
  - Logical constraints for commodities that can be carried by each vessel class and dock
  - Statistical information relating to physical characteristics of each vessel class and loading characteristics

Synthetic Vessel Call Generator – Approach

1. Generate synthetic fleet
2. Loop



   Assign Portion of Commodity Forecast at Dock to a Single Generated Vessel

   Decrement Forecast at Dock and Available Fleet

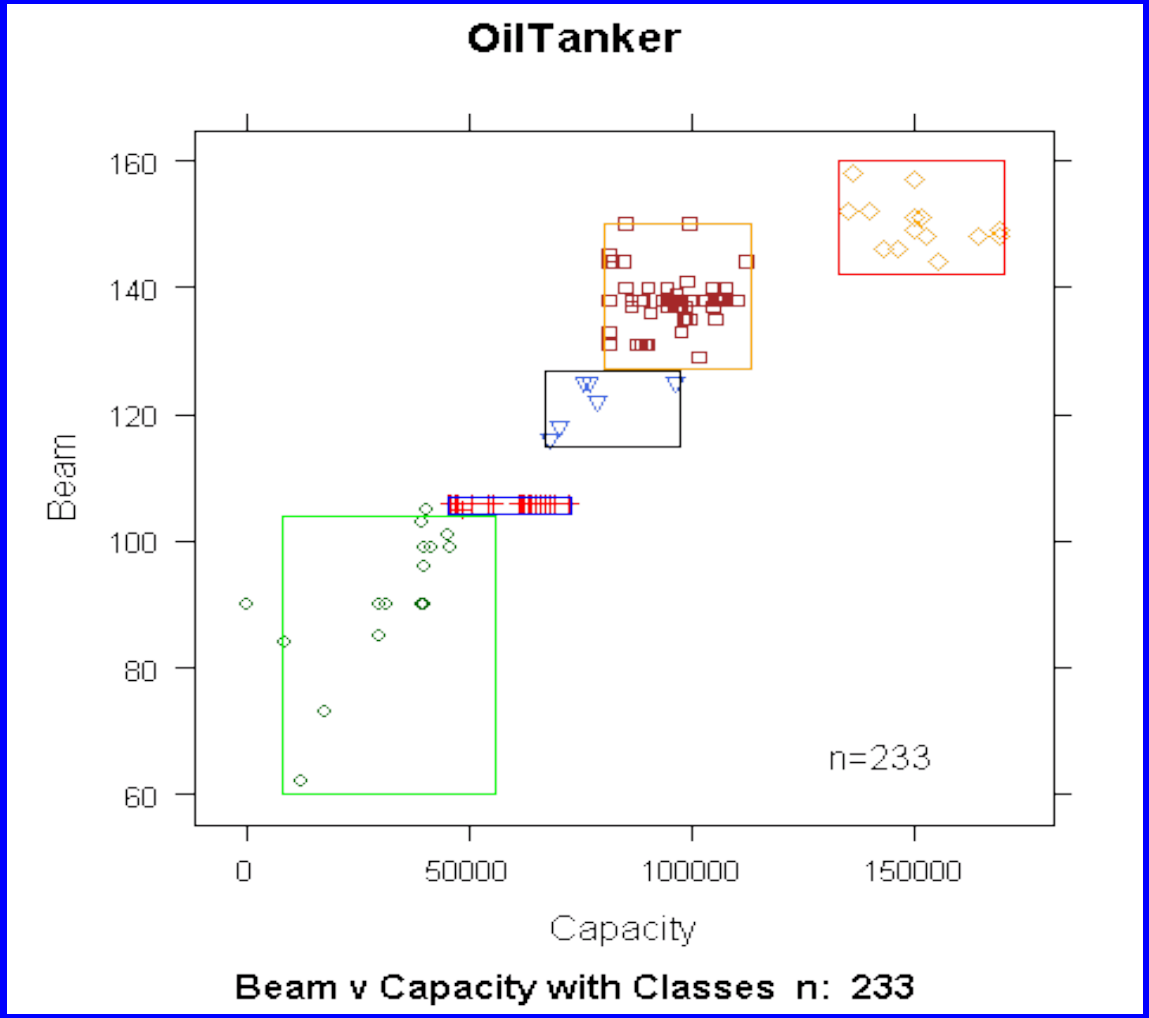
   Until no more assignment possible

   - forecasts satisfied
   - no more available fleet

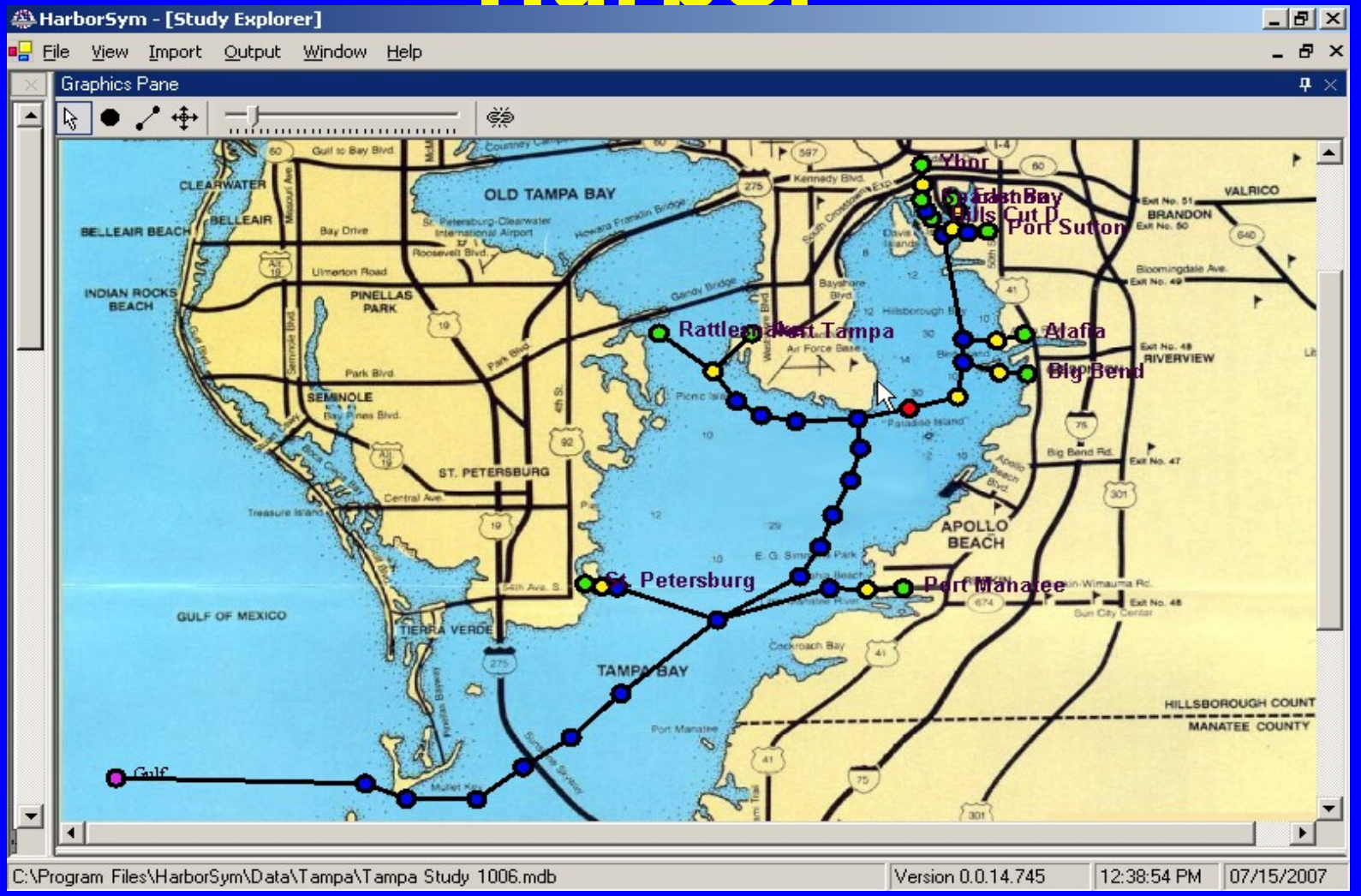
3. Assign arrival times to each generated call

Vessel Classification using data analysis tool

- Import Historical using Types
- Cluster analysis on capacity, beam to locate classes
- Review,
  revise import



Model Application – Tampa Harbor



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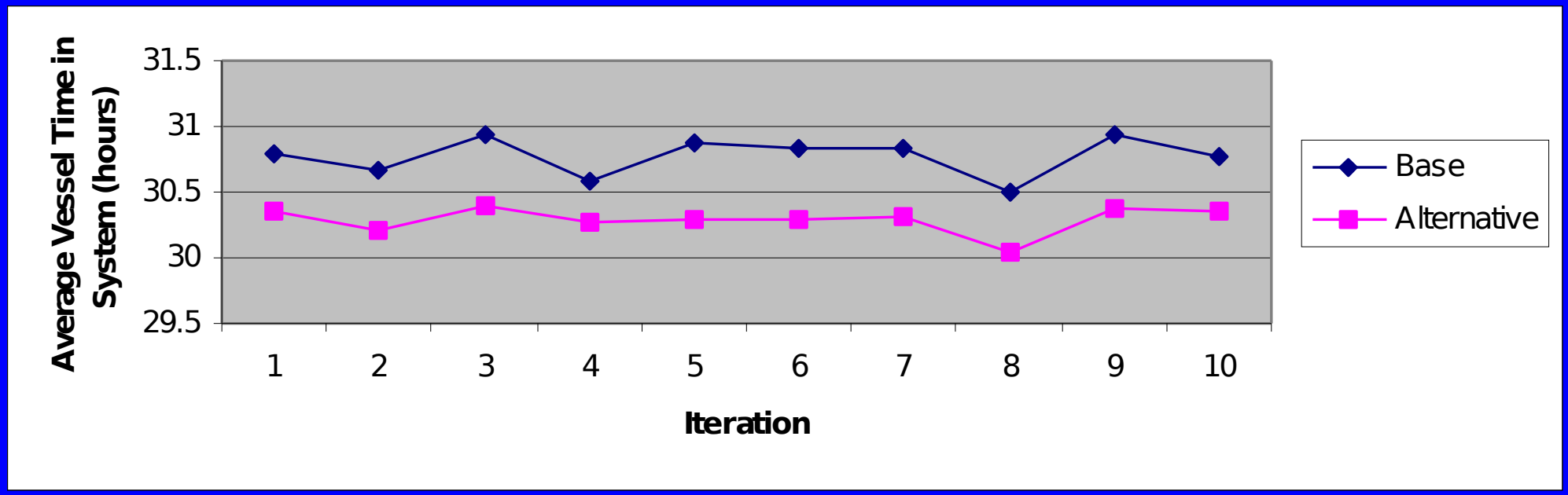
Tampa harbor reach-rule restrictions

Rule description	Application parameters
Multiple vessel rules	
Combined beam width restriction	No meeting if beams exceed 42% of channel width
Restricted movement with priority vessels	No overtaking, passing or meeting
Single vessel rules	
Restricted movement by vessel LOA, beam or capacity	LOA (800’ maximum)
Draft limit	43’ maximum draft
Single vessel environmental rules	
Maximum draft plus tidal allowance	40’ + tide max draft (Area 1)
Maximum draft plus tidal allowance	33’ + tide max draft (Area 2)

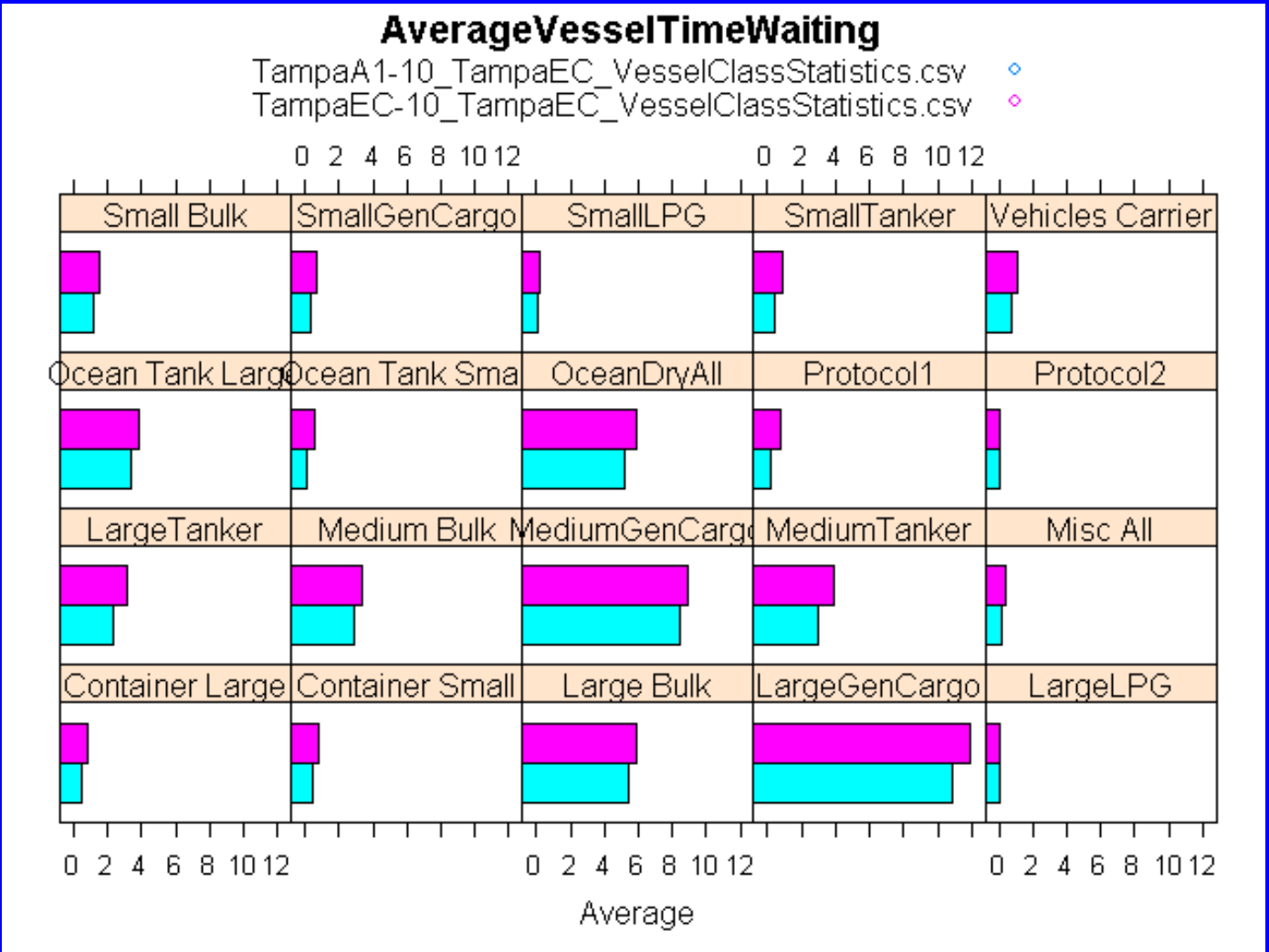
Tampa harbor base condition vessel calls and tonnage by vessel class (selected classes)

Vessel class	Import tons	Export tons	Vessel calls
Large tanker	8657625.54	5744.14	290
Ocean tank large	8358189.84	0.00	397
Ocean dry all	4422056.36	4024677.60	298
Large bulk	2852159.14	1333596.52	95
Medium bulk	2244840.38	4792327.96	351
Medium tanker	1894981.05	78623.15	132
Large LPG	1414704.91	0.00	54
Container large	629782.98	157461.40	37
Large Gen Cargo	572725.37	358388.40	68
Small gen cargo	123995.95	626564.78	265
Protocol 2	30371.80	28882.40	138
Protocol 1	7760.20	7309.90	98

Average Vessel Time in System



Comparison of Alternatives



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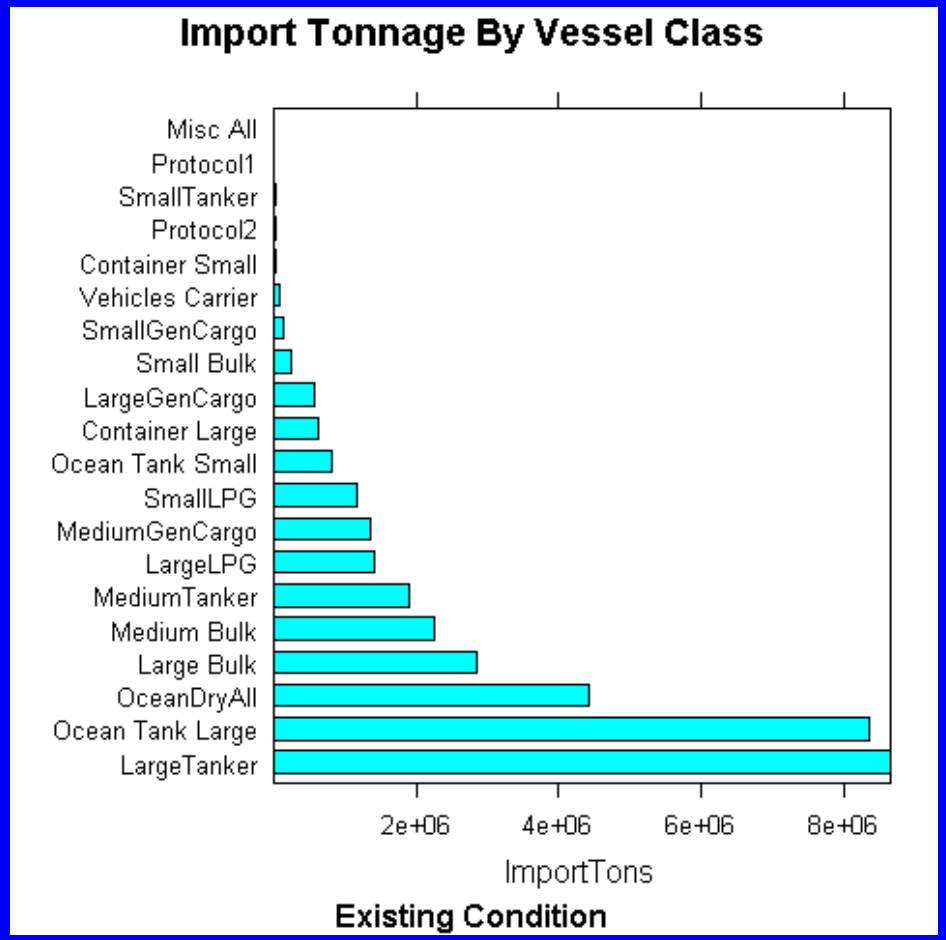
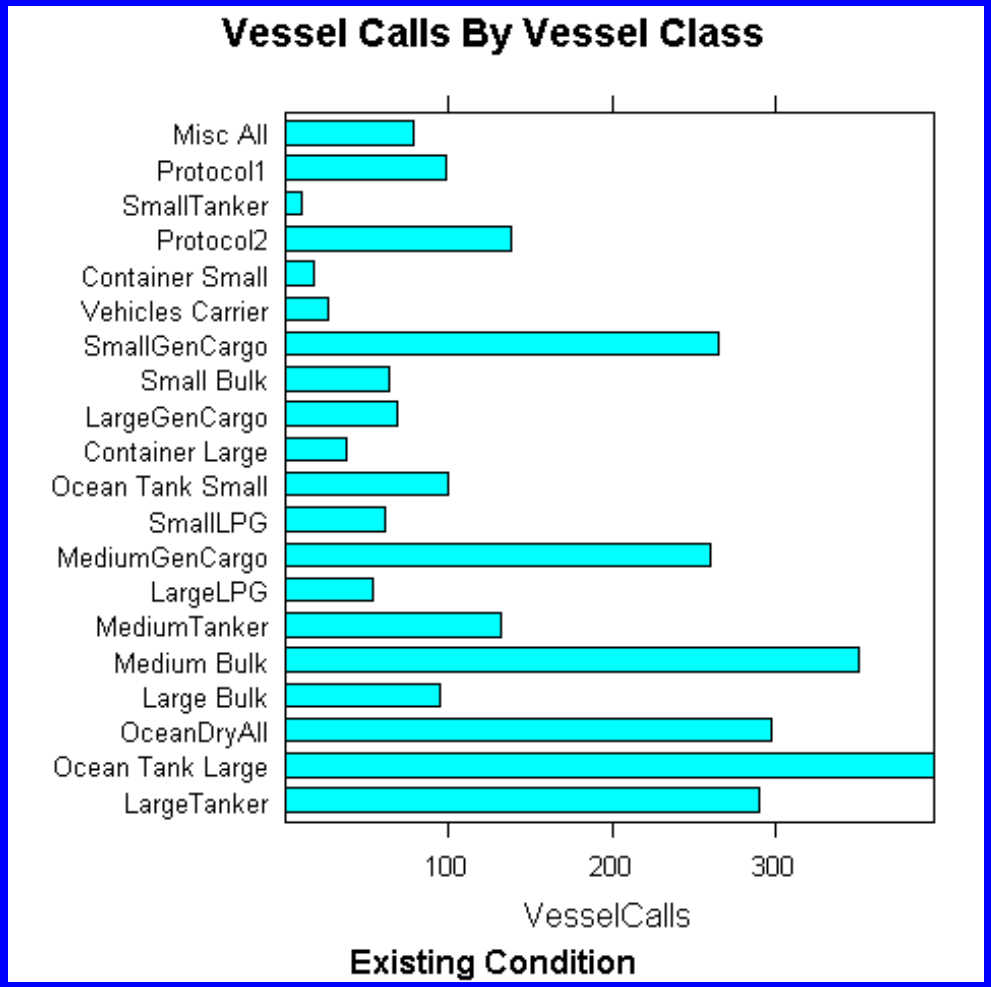
Data Summarization





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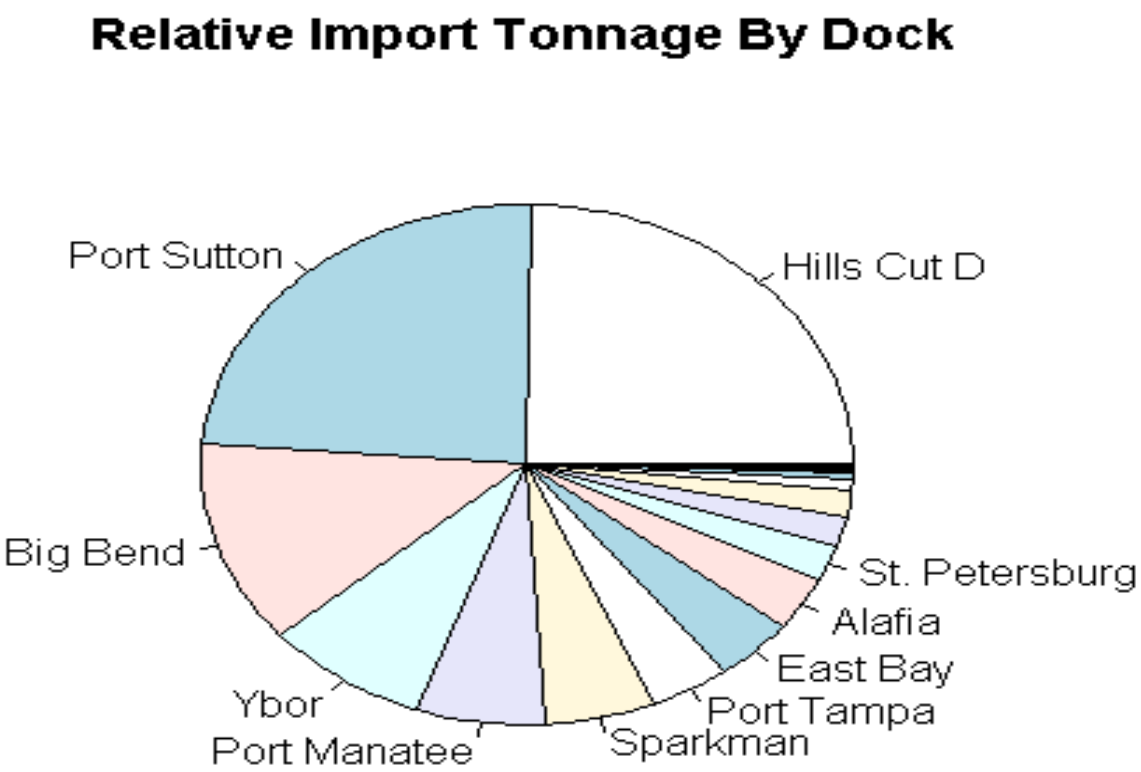
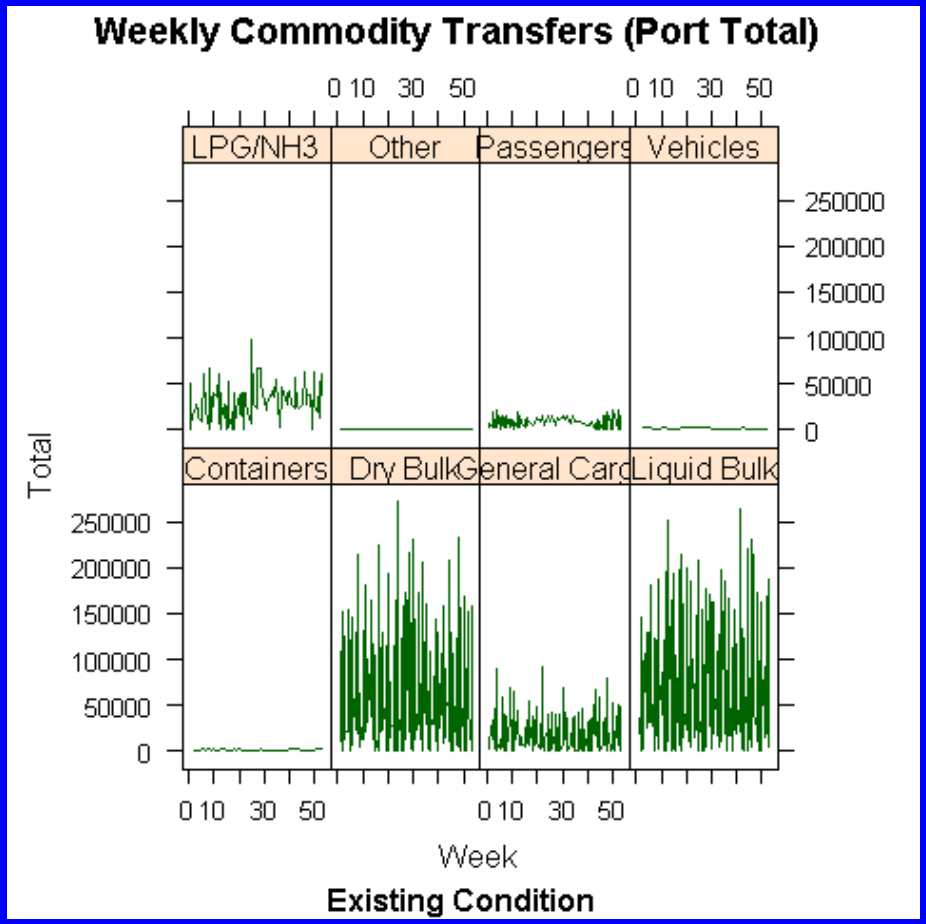


Flow of Commodity To Port / Docks



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Example Transit times and delay costs for existing condition and improvement, 2004 vessel calls		
	Existing channel	**Proposed enhancement**
Average Vessel Time in System (hours)	30.1	29.7
Average Vessel Delay Time (hours)	3.2	2.7
Total Transportation Costs ($)	74,898,000	73,745,000

Future Direction

- Integration of the various modules of HarborSym into a single package is currently underway.
  - Widening model
  - Deepening model
  - Synthetic call generation
  - Data analysis and visualization
- Incorporation of the ability to estimate and forecast emissions from fleet operations at the harbor.

Conclusions & Summary

- HarborSym has proven to be a worthwhile tool for economic analysis of proposed channel widening projects.
- The visualization and data analysis tools, results viewing and animation of the simulation assist the analyst to calibrate the model and communicate results.
- HarborSym allows significant transparency of the analysis appropriate for public investment decisions.
- The data-driven architecture allows HarborSym to be used for many ports and improvement alternatives without significant recoding. This allow consistent analytical treatment to harbors across the country.

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Questions?